Comments on:

ENVIRONMENTAL TOBACCO SMOKE:

A GUIDE TO WORKPLACE SMOKING POLICIES

[Draft] EPA 400/6-90/004

Response Addressing:

Chapter 1: What Is ETS?

Section: Measuring ETS in the Air and Body

Topic: Diffusion

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SUMMARY: The statement "Researchers have found that ETS diffuses rapidly through buildings, persists for long periods after smoking ends, and represents one of the largest sources of indoor particle pollution" found in the key points section (Chapter 1, page 3) of the EPA draft document "Environmental Tobacco Smoke: Guide to Workplace Smoking Policies" is misleading and incorrect. Problems with the statement are described.

COMMENTS: The Key Points Section [The Guide, pp. 3, 4] of the EPA draft document "Environmental Tobacco Smoke: Guide to Workplace Smoking Policies" [referred to as the "Guide" hereafter], contains an unsubstantiated, misleading argument which is central to the justification of the authors' conclusion. This comment was written to address the statement "Researchers have found that ETS diffuses rapidly through buildings, persists for long periods after smoking ends, and represents one of the largest sources of indoor particle pollution." This statement is inaccurate and misleading. A more appropriate statement is "Measurements have shown that ETS is diluted rapidly in buildings, and it is frequently difficult to determine whether or where smoking has occurred. Most ETS constituents are removed rapidly from building interiors by dilution with fresh air infiltrating the building or introduced into the air handling system. A few ETS components such as nicotine have been shown to readily adsorb onto and desorb from interior surfaces. Because of this behavior, these components are unreliable indicators of exposure to ETS. ETS can be a major source of particles in smoking areas, but may be only a minor source of particulate pollution in non-smoking areas within the same building." The flaw in the Guide's statement is explained below.

The term "diffuses" implies that ETS is found at similar concentration throughout a building, even when the source is well removed from the measurement site. ETS can be distributed in buildings with recirculated air. But, in the process, ETS constituents are rapidly diluted to insignificant concentrations. Problems with mathematical models of others which assume rapid diffusion and good mixing in indoor air spaces are outlined by Kim *et al.*[1]. In addition, Kim has showed through modeling that ETS is rapidly removed from an office space once smoking has stopped [1].

A number of studies have been performed in office buildings which not only have segregated smoking areas, but also rely on some recirculated air for ventilation (a typical situation). Sterling examined the influence of ventilation and smoking-rate parameters on ETS concentrations in indoor environments [2]. His data indicated minimal recirculation of ETS between smoking and nonsmoking areas -- areas on different floors or within different sections of a single large room. In his study, smoking and nonsmoking areas of a cafeteria (which were neither separately ventilated nor physically separated (could be distinguished by nicotine or RSP measurements. In this case, different concentrations of ETS components were measured within the same room. Concentrations were lower in areas further from the cafeteria, even though served by the same ventilation system [2]. Sterling's work supports Kim's conclusions regarding the existence of concentration gradients within the same room [1]. Sterling also found that nicotine concentrations were below the detection limit in nonsmoking offices [2] -- offices that shared recirculated air from the cafeteria. RSP concentrations were also low and apparently unaffected by ETS [2].

In a large volume university amphitheater where a few students smoked between classes, Arfi [3] measured either no or low nicotine concentrations. The reason given for the lack of nicotine was "dilution into the large air volume and good ventilation of the amphitheater."

One of the most detailed studies reported was performed in an "energy efficient" office building. The heating, ventilating and air conditioning (HVAC) system provided air to the offices at three air changes per hour, and had a maximum recirculation rate of 84%. Although the maximum recirculation rate is rarely used; the actual recirculation rate varied throughout the day. Chromatographic profiles of the atmospheres in multiple-occupant offices with one or zero smokers were similar[4]. Lack of difference between chromatographic profiles of air from smoker's and non-smoker's offices has also been reported by others [5]. Nicotine concentrations were considerably lower in offices in which no smoking occurred, than those in offices on the same or different floors in which smoking occurred. When total RSP was examined, there was little difference among the offices [4]. However, a method to estimate the contribution of ETS to total RSP has been developed [6] and was applied in the study[4]. The apportionment technique showed that ETS contributed only <6% to 40% toward the total RSP in the building. In one non-smoker's office, a mean RSP concentration of 52 $\mu g/m^3$ was measured, to which ETS contributed a maximum of 3 $\mu g/m^3$. The highest RSP concentration, 148 $\mu g/m^3$, was measured in the office of a smoker. However, of this total, only 61 $\mu g/m^3$ were attributable to ETS. The

majority of the particulate matter in each of these offices arose from sources other than ETS [4].

Nicotine has been demonstrated to be an inadequate marker for ETS exposure because its ratio to other ETS constituents is highly variable [7-12]. The origin of the variation is probably due to non-first order decay kinetics and its ability to reversibly adsorb on surfaces [7,8]. Most other ETS constituents studied to date appear to follow first order decay kinetics with a decay rate constant nearly equal to the air exchange rate [7,8]. The office study found that, in general, total and specific volatile organic compounds showed no relationship to smoker density or number of smokers in an office [4].

Removal of ETS from an interior environment is proportional to air exchange rate. If a building is properly ventilated, the process should be both rapid and efficient. It has been clearly demonstrated [7,8,13] that most ETS constituents (for which measurements have been made) are removed from a room at a rate proportional to the air exchange rate. Nicotine is an exception to this rule. Nicotine has a demonstrated ability to reversibly adsorb onto interior surfaces and smoker's clothing and self [7,8]. For example, nicotine has been detected in aircraft and buildings long after smoking occurred and other ETS constituents were removed by air exchange. Also, significant desorption of nicotine from a smoker was demonstrated in a controlled environment test chamber in the absence of ETS production [7].

The contribution of ETS to indoor air particulate matter has been addressed several times in the literature. Making the assumption that all indoor air RSP is attributable to ETS is not valid. Likewise, one cannot assume that indoor air background RSP values are equal to outdoor values (although they sometimes are). The office study of Baker [5] clearly illustrates this point, as do the studies of Oldaker *et al.* [6,14].

Although ETS may affect indoor air quality, it is neither the only nor the most serious problem with indoor air quality. This is shown by two studies of sick building syndrome. One company studied indoor air quality in over 39 million square feet of property between 1981-1987 (223 buildings), ETS was found to be the most significant pollutant in only 4% of the buildings [15]. In another sick building database, smoking was implicated as the problem in only 12 of 408 (<3%) of the buildings surveyed [16]. Despite this compelling body of work, the EPA document recommends major efforts to control a relatively minor (albeit visible) factor in indoor air quality. Furthermore, the smoking bans suggested in the report will do nothing to correct unseen or unnoticed problems with indoor air quality which may have more serious health consequences than ETS. That banning smoking will make indoor air "safe", as is deceptively implied in the document, is not justified on the basis of indoor air quality research.

RECOMMENDATIONS: The statement, "Researchers have found that ETS diffuses rapidly through buildings, persists for long periods after smoking ends, and represents one of the largest sources of indoor air particle pollution," found in chapter one, page 3 should

be eliminated or rephrased to read "Measurements have shown that ETS is diluted rapidly in buildings, and it is frequently difficult to determine whether or where smoking has occurred. Most ETS constituents are removed rapidly from building interiors by dilution with fresh air infiltrating the building or introduced into the air handling system. A few ETS components such as nicotine have been shown to readily adsorb onto and desorb from interior surfaces. Because of this behavior these components are unreliably indicators of exposure to ETS. ETS can be a major source of particles in smoking areas, but may be only a minor source of particulate pollution in non-smoking areas within the same building."

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